antenna port in resource **3**. TPs use different precoders, for example, [1 1], [1 1], [1 j], [1 −j], from one occasion to another. For example, in subframe 1, TP**1** may use [1 1] to map physical antennas **1** and **3** on TP**1** to antenna port **0** in resource **3**, and TP**2** may use [1 −1] to map physical antennas **1** and **3** on TP**2** to antenna port **1** in resource **3**. If it happens that the desired codeword on resource **1** is [1 x 1 y] and the desired codeword on resource **2** is [1 a-1 b], then the feedback PMI on resource **3** is useful for a base station such as an eNodeB (eNB) to determine the phase difference, or construct an estimate of the phase difference, between two TPs. Otherwise, a user device, such as a user equipment (UE) or an eNB must wait until the right combination is used on resource **3** to determine the phase difference between two TPs. Additional examples are described below. It can be seen that in one or more embodiments of the invention, resource **3** may be used in a time division multiplexing (TDM) fashion for all UEs being served by TP**1** and TP**2**, and the feedback on resource **3** is useful when the proper combination of precoded transmissions occurs on both TPs.

[0103] In another approach, a factorization of the rotation matrix is performed. At each TP, a fixed precoding matrix, obtained from the factorization of the rotation matrix, is applied to two physical antennas. The precoded signal is mapped to one port in resource **3**. An eNB does not change the precoder applied on physical antennas from resource **3** from one occasion to another, and so the feedback from resource **3** always provides information relating to the correct phase difference, as well as preventing the loss of reliability of phase information associated with fading.

[0104] Embodiments of the present invention recognize that a receiver, such as a receiver of a UE, may be modeled as:

$$r=(H_1v_1+H_2v_2\alpha)x+n$$

The co-phase optimization involves changing α to maximize

$$(H_1v_1+H_2v_2\alpha)^H(H_1v_1+H_2v_2\alpha)=v_1^HH_1v_1+v_2^HH_2^HH_2v_2+2re(v_1^HH_1^HH_2v_2\alpha)$$

Low-rank approximation may be used for both H_1 and H_2:

$$H_1\approx c_1v_1^H$$

$$H_2\approx c_2v_2^H$$

[0105] The following expression can be derived from the equations above:

$$2re(v_1^HH_1^HH_2v_2\alpha)=2re(c_1^Hc_2\alpha)$$

Assuming a low-rank approximation, a can also be determined from correlation between two matrix channels.

[0106] In one approach, UE selected precoders may be used. These may be v**1**, v**2**, which can be derived from the channel state information reference signal (CSI-RS) resources configured for single cell CSI on the CSI-RS ports. This yields:

$$tr((H_1v_1)^H(H_2v_2))=tr(v_1^HH_1^HH_2v_2)$$

[0107] It may be desirable to restrict the selection of probing antennas used in each TP, and in such a case, the combination of v**1** and v**2** is limited. It may therefore be feasible for the eNB to obtain PMI feedback from a group of UEs {v**1**, v**2**}. Depending on system configuration and prevailing conditions, the eNB may trigger aperiodic CSI feedback, allowing a group of UEs that happen to have the same {v**1**,v**2**} to feed back the PMI from an inter-TP CSI-RS resource. For UEs set to send periodic CSI, it may be desired to use only the feedback matching the precoder combination {v**1**,v**2**} at the eNB.

[0108] In a second approach, all the UEs configured with an inter-TP CSI-RS resource may use the resource to compute a PMI, and the PMI may be suitable for both periodic and aperiodic CSI feedback. Transmission may be performed on CSI-RS ports, with the UE forming the correlation:

$$tr(H_1^HH_2)\approx tr(v_1c_1^Hc_2v_2^H)=(v_2^Hv_1)=(v_2^Hv_1)(c_1^Hc_2\mathbf{0}$$

[0109] Yet if v_1 happens to be orthogonal with v_2, then the correlation formed here is zero.

[0110] Therefore, embodiments of the present invention introduce a rotation precoderR at TP**2**. In an exemplary embodiment, both TP**1** and TP**2** may be 2 Tx, that is, using two transmission antennas. The use of the rotation precoder yields

$$tr(H_1^H{}_2R)\approx tr(v_1c_1^Hc_2v_2^HR)=(v_2^HRv_1)(c_1^Hc_2)$$

[0111] Transmission point configurations may be chosen so that $(v_2^HRv_1)$ is non-zero for all v_1 and v_2. Consequently for 4Tx (using four transmit antennas at each TP), only the first and third antennas are mapped to the resources. For 8 Tx (using 8 transmit antennas at each TP), only the first and fifth antennas are mapped to the resources. With this restriction, the codeword v_1 and v_2 can only take values from [1 1], [1 −1], [1 j], and [1 −A. By introducing the precoder R, effectively the UE finds the best PMI matches with

$$(v_2^HRv_1)(c_1^Hc_2).$$

[0112] The rotation matrix R is given by

$$\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

[0113] It is also possible to split the rotation matrix into two parts, with each part being used at a TP:

$$\begin{aligned} R_1 &= R_2^H \\ &= \begin{bmatrix} 1.0000 & 0.3334-0.4714i \\ 0.3334-0.4714i & 0.3332+0.9429i \end{bmatrix} \end{aligned}$$

[0114] FIG. **11** therefore illustrates a first transmission point **1100** comprising ports **1102**A-**1102**D, and a second transmission port **1150** comprising ports **1152**A-**1152**D. A first CSI-RS resource **1110** is configured across the ports **1102**A-**1102**D of the transmission point **1100** and a second CSI-RS resource **1160** is configured across the ports **1152**A-**1152**D of the transmission point **1150**. The first resource may have a first precoded transmission **1115** with a PMI **1** and the second resource may have a second precoded transmission **1165** with a PMI **2**.

[0115] An inter-transmission point CSI-RS resource may be configured on ports **1102**A and **1152**D to identify the co-phasing coefficient a. However, if the port **1102**A or **1152**A suffers fading, the identified α is not reliable. A first embodiment of the invention, therefore, provides for the configuration of a third resource CSI-RS **1180** across specified ports of the first and second transmission points **1100** and **1150**, respectively. The third CSI-RS resource may, for example, be configured on port **1100**A and port **1152**A. Not